

**Final Report for Period:** 04/2001 - 03/2003**Submitted on:** 07/30/2003**Principal Investigator:** Bergin, Michael H.**Award ID:** 0080325**Organization:** GA Tech Res Corp - GIT**Title:**

Measurement of Aerosol Chemical, Physical, and Radiative Properties Related to Direct Climate Forcing in China

**Project Participants****Senior Personnel****Name:** Bergin, Michael**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Chameides, William**Worked for more than 160 Hours:** No**Contribution to Project:****Name:** Cass, Glen**Worked for more than 160 Hours:** No**Contribution to Project:****Post-doc****Name:** Carrico, Christian**Worked for more than 160 Hours:** Yes**Contribution to Project:****Graduate Student****Name:** Xu, Jin**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Greenwald, Roby**Worked for more than 160 Hours:** No**Contribution to Project:****Undergraduate Student****Technician, Programmer****Other Participant****Research Experience for Undergraduates****Organizational Partners****University of Wisconsin-Madison**

Filter samples were collected during the field project, and a fraction of the filters were analyzed at the University of Wisconsin-Madison by Dr. James Schauer.

**Other Collaborators or Contacts**

Dr. Jamie Schauer at the University of Wisconsin at Madison analyzed filters for organic carbon, elemental carbon, and elements

**Activities and Findings**

**Research and Education Activities:** (See PDF version submitted by PI at the end of the report)

**Findings:** (See PDF version submitted by PI at the end of the report)

**Training and Development:**

There have been 2 graduate students and a postdoctoral researcher that have worked on the project, and thus the project has served to train researchers in the PI's group. In addition, an undergraduate student has been involved in data analysis as well as various aspects of the chemical analyses of filters.

In addition, Chinese scientists aided in obtaining samples during the field project. Therefore, the project allowed for the training of foreign scientists. It is anticipated that the scientists in China will use the knowledge gained during this collaborative study to continue studies related to aerosols and climate in Yulin.

**Outreach Activities:**

A description of the project as well as preliminary results can be found at <http://www.ce.gatech.edu/~mhbergin>.

**Journal Publications****Books or Other One-time Publications****Web/Internet Site****URL(s):**

<http://www.ce.gatech.edu/~mhbergin/>

**Description:****Other Specific Products****Contributions****Contributions within Discipline:**

As part of the ACEAsia field campaign our research group made some of the first measurements of aerosol optical properties in the Gobi desert region of China. When combined with chemical analyses our results show that even in remote desert regions of China anthropogenic sources influence aerosol properties. This research provides a database of aerosol properties that will be useful as inputs and validation to models that assess the impact of aerosols on climate and human health.

**Contributions to Other Disciplines:**

At this time it is difficult to assess the contribution of the research to other disciplines. One possible contribution is that our study supplies information on aerosol properties from a region where data is sparse. This data may be useful for future researchers seeking to understand the impact of aerosols on climate and crop growth.

**Contributions to Human Resource Development:**

Perhaps one of the most important aspects of our project was technology transfer. During our stay in Yulin, China we trained several technicians on aspects related to aerosol sampling. Our sampling was conducted at a local meteorological station. For the last 2 weeks of the month-long field effort our Chinese colleagues ran our instruments, and results indicate that they were successful at gathering data and keeping all of our sampling devices working properly. The station is currently involved in aerosol sampling with our Chinese counterparts and we feel that our training was essential for the future sampling at the site.

### ***Major Research and Education Activities***

As part of the project the PI and a graduate student (Jin Xu) traveled to Yulin, China to conduct field sampling during April, 2001. Yulin is a town with a population of ~60,000, located in the arid Northern region of the Shaanxi province within ~ 100 km of inner Mongolia and the Mu Us desert. Continuous measurements of aerosol optical properties (light scattering and absorption coefficient) as well as downwelling solar irradiance were made as well as a variety of meteorological parameters. In addition, the wavelength dependant aerosol optical depth was measured during clear-sky conditions. Filters were collected for analysis of aerosol chemical and physical properties. It is worthwhile to point out that measurements were made during the entire field campaign, and therefore no gaps exist in the collected data. Also, the data set represents the only measurements of aerosol radiative properties made in the vicinity of the Gobi desert region during the ACEAsia field study.

All continuously measured parameters have been screened for erroneous values and the final version of the database generated. All filters have been weighed and aerosol mass concentrations determined for each day of the month long experiment. The mass concentrations of major ionic species have also been determined for each of the samples, as well as the concentrations of organic carbon, elemental carbon, and specific elements. The research activities have in part served the purpose of training 2 graduate students (Jin Xu and Roby Greenwald) and a postdoctoral researcher. In addition, an undergraduate student (Kristen Parks) has been involved in analyzing data. Several presentations have been given related to the research, including:

1. Russell, P.B., Schmid, B., Bergstrom, R.W., Redeman, J., Livingston, J.M., Holben, B., Nakajima, T., Pilwesk, P., Flatau, P.J., Vogelmann, A., Bergin, M., Hsu, N.C., Seinfeld, J., Hegg, D., Quinn, P., Overview of ACE-Asia spring 2001 investigations on aerosol-radiation interactions, *American Meteorological Society Meeting*, Orlando, FL, Jan. 2001 (abstract and presentation by P.B. Russell).
2. Bergin, M.H., Aerosol Chemical, Physical, and Radiative Properties at Several Locations in China, *Hong Kong Air and Waste Management Association (HKAWMA) winter meeting*, Dec. 2001 (abstract and invited presentation by M.H. Bergin).
3. Russell, P.B., Valero, F.P.J., Flatau, P.J., Bergin, M., Holben, B., Nakajima, T., Pilewskie, P., Bergstrom, R.W., Schmid, B., Redemann, J., Livingston, J., Vogelmann, A., Wang, J., Seinfeld, J., Hsu, N.C., Hegg, D., Overview of ACE-Asia spring 2001 investigations on aerosol radiative effects and related aerosol properties, *AGU Fall Meeting*, San Francisco, Dec. 2001 (abstract and presentation by P.B. Russell).
4. Bergin, M.H., Xu, J., Carrico, C.M., Schauer, J., Aerosol chemical, Physical, and radiative properties in Yulin, China: Preliminary ACEASIA measurements, *ACEASIA Science Team Meeting*, Pasadena, CA, Nov, 2001 (poster and presentation by M.H. Bergin).
5. Xu, J., Bergin, M.H., Greenwald, R., Schauer, J., Jaffrezo, J.L., Aymoz, G., Direct aerosol radiative forcing based on chemical, physical, and radiative properties in Yulin, China during

ACE-Asia, American Association of Aerosol Research Annual Meeting, Charlotte, NC, Oct. 2002 (abstract and oral presentation by J. Xu).

6. Bergin, M.H., The Whitehouse effect and why we can see the air, School of Environmental Studies, Emory University, April, 2003 (presentation by M.H. Bergin).
7. Xu, J., Radiative Forcing in China, NOAA CMDL, May, 2003 (presentation by J. Xu).

### ***Major Research Accomplishments***

Results indicate that several major dust storms occurred in the region during the field campaign resulting in aerosol loadings responsible for visibility's as low as 1 km. The site is unique in that it allows for the sampling of both local pollution, and wind-blown dust. During the late evenings and early mornings the air is typically stagnant with aerosol sources dominated by local burning of coal and biomass. With the exception of the large dust storms, both the light scattering and absorption coefficient are highest in the early morning. During the afternoons the wind speed typically increases. At the same time the wind direction changes, bringing air from desert regions to the north and west. The single-scattering albedo (which is the ratio of light scattering to light extinction) generally increases from  $\sim 0.90$  to  $0.95$  from the mornings to the afternoons. This suggests that dust is relatively less absorbing compared to the locally generated aerosol, which likely contains a significant amount of soot from combustion sources. The aerosol chemical composition during days influenced by local pollution was dominated by organic compounds which accounted for  $\sim 40\%$  of the fine particle mass. Other contributors included sulfate which originated from the local burning of coal ( $\sim 20\%$ ) and elemental carbon ( $\sim 10\%$ ) having contributions from a variety of combustion sources. Not surprisingly, during the dust events the aerosol mass was composed primarily of elements such as silicon, aluminum and calcium. Measurements of aerosol optical depth combined with model estimates and measurements of surface irradiance suggest that during clear days aerosols are responsible for a  $\sim 10 - 20\%$  reduction in the amount of solar radiation reaching the surface. Overall, it would appear that both locally generated anthropogenic aerosols associated with fossil fuel combustion and biomass burning as well as wind-blown dust significantly impact the surface radiation balance of the region. We are currently working on a journal paper that will be submitted to the upcoming ACEAsia special issue of the Journal of Geophysical Research.